PF-400-8.0, Final, Rev.3

Mars Pathfinder Project

Archive Generation, Validation, and Transfer Plan

Final, Rev.3

July, 1998

JPL
Jet Propulsion Laboratory
California Institute of Technology

JPL D-14432, Final, Rev. 3

Mars Pathfinder Project Archive Generation, Validation, and Transfer Plan

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Document # PF-400-8.0
8/17/98

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ACRONYMS

A SOG	Atmospheric Sciences SOG
AIR SOG	Atmospheric Imaging Research SOG
ATDF	Archival Tracking Data File
APXS	Alpha-Proton X-ray Spectrometer
ARC	Ames Research Center (NASA)
ASI/MET	Atmospheric Structure Instrument/Meteorology Package
CD	Compact disc
CK	SPICE kernel containing C-matrix (orientation) information
CODMAC	Committee on Data Management and Computation
Co-I	Co-Investigator
DSN	Deep Space Network
DTM	Digital Terrain Model
EDL	Entry, Descent, and Landing
EDR	Experiment Data Record
EEIS	End-to-End Information System
EH&A	Engineering, Housekeeping and Accountability
EK	SPICE kernel containing event information
ENB	SPICE Experimenter's Notebook
FIST	Facility Instrument Science Team
IK	SPICE kernel containing instrument information
IMP	Imager for Mars Pathfinder
JPL	Jet Propulsion Laboratory
LSK	SPICE kernel containing leap seconds (used in some time conversions)
MFEX	Microrover Flight Experiment (AKA: Rover, Sojourner)
MIPL	Multi-mission Image Processing Laboratory
MPAe	Max Planck Institut fur Aeronomie
MPF	Mars Pathfinder
NAIF	Navigation and Ancillary Information Facility
NASA	National Aeronautics and Space Administration
NAV	Navigation
NSSDC	National Space Science Data Center
ODF	Orbit Data File
OSAT	Office of Space Access and Technology
PAWG	Pathfinder Archive Working Group
PcK	SPICE kernel containing planet physical and cartographic information
PDB	Project Database
PDS	Planetary Data System
PI	Principal Investigator
PS	Participating Scientist
PSG	Project Science Group
SCLK	Spacecraft clock; also, SPICE kernel containing spacecraft clock coefficients
S/C	Spacecraft
SOG	Science Operations Group
SPICE	Spacecraft Planet Instrument C-matrix Events (NAIF)
SPK	SPICE kernel containing ephemeris data for any number/types of solar system objects (e.g. spacecraft, planet, sun, satellite).
SIS	Software Interface Specification
TL	Team Leader
USGS	United States Geological Survey

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Figures & Tables:

1.0 INTRODUCTION

1.1 Purpose

The purpose of this document is to provide a plan for generation, validation, and transfer to the Planetary Data System (PDS) of Mars Pathfinder (MPF) archives containing raw and reduced data, documentation, algorithms and software.

1.2 Scope

This plan covers archiving of raw and reduced science data and related information beginning with the Cruise phase, through the Surface Operations and Extended Mission Phases. The Prime Surface Phase began July 4, 1997 and ended in early August, 1997. The Extended Mission Phase continued until loss of contact with the Spacecraft in late September, 1997.

This plan also covers archiving of telemetry packet engineering data throughout the MPF mission.

Specific activities addressed in this plan are:

1. Generation and validation of MPF archive volumes containing raw and reduced data products, software, algorithms, documentation, and ancillary information.

2. Generation of high-level mission, space-craft and instrument documentation, instrument calibration reports, algorithms, and documentation of software used to produce reduced data records.

3. Generation of SPICE archives for use with software from the Jet Propulsion Laboratory's Navigation and Ancillary Information Facility (NAIF).

4. Delivery to the PDS of validated MPF archives.

1.3 Contents

This plan begins with a summary of the MPF Data Release Policy. This section is followed by a description of the archiving functions, and roles and responsibilities for organizations and personnel associated with generation, validation, and archiving of MPF data. The data sets planned for archive are defined for each instrument or experiment. The core MPF data will form ten volume sets: one or more for each instrument, plus engineering and SPICE collections. The expected volumes, their contents and suppliers are detailed in Table 5. Appendix I is a glossary of selected terms used in this document. Appendix II defines the NASA and CODMAC data processing levels. Appendix III contains descriptions of the MPF data products. Appendices IV and V provide outlines of a standard SIS for a PDS archive volume collection and an outline of a standard PDS volume, respectively.

1.4 Applicable Documents and Constraints

The MPF Archive Generation, Validation, and Transfer Plan is responsive to the following Mars Pathfinder documents:

Proposal Information Package, AO 96-OSS-01, July 25, 1996.

Mission Plan, Rev A, JPL D-11355, April 1995.

Science & Instruments Requirements Document, MPF-400-6.0, Rev. 3, March 15, 1996.

The plan is consistent with the principles delineated in the following National Academy of Sciences reports:

Data Management and Computation, Volume 1, Issues and Recommendations, 1982, National Academy Press, 167 p.

Issues and Recommendations Associated with Distributed Computation and Data Management Systems for the Space Sciences, 1986, National Academy Press, 111 p.

The plan is also consistent with the following Planetary Data System documents:

Planetary Science Data Dictionary Document, July 15, 1996. JPL D-7116, Rev. D.

Planetary Data System Data Preparation Workbook, February 1995, Version 3.1, JPL D-7669, Part-1.

Planetary Data System Standards Reference, July, 1995, Version 3.2. JPL D-7669, Part-2.

Finally, the plan is consistent with the contracts negotiated among the MPF Project, Principal Investigators and Team Leaders, Participating Scientists, and Facility Instrument Science Team (FIST) members in which reduced data records and documentation are explicitly defined as deliverable products.

2.0 MARS PATHFINDER DATA RELEASE POLICY

The MPF Data Release Policy, which is part of the Proposal Information Package, states the Project's policy and agreement with its participants for the creation and release of data products. It defines the schedule and process at a high level. Portions of the policy which relate to archival data are reflected in this Plan. These include specifications on types of data to be archived; responsibilities of the Team Leaders, Instrument Teams and Principal Investigators; and the time required for production and validation.

3.0 OVERVIEW OF ARCHIVING FUNCTIONS

Standard products form the core of the archives to be produced by MPF and released to the PDS for distribution to the science community. These products and associated raw data, calibration data, SPICE files, and ancillary information will be placed on archive volumes (CDs) for validation and transfer to the PDS (see Table 5 for description of each volume or volume set).

In the following sections we discuss the processes and schedules for generation and validation of standard products and archive volumes and delivery to the PDS. Figure 1 shows the flow of components through the various stages of archive volume generation, validation, transfer to the Planetary Data System, and distribution of products to the science community.

3.1 Generation

Generation of the MPF archive will begin at JPL with the engineering data record archive volumes which will be created by the project Engineering Data Team, and generation of the science experiment data record volumes by the Multi-mission Image Processing Laboratory (MIPL). Generation of archive volumes of raw radio science data is the responsibility of the Rotational and Orbital Dynamics Team.

The Instrument Teams will generate reduced data records (as standard data products), documentation, algorithms and/or software to generate reduced products in the form of archive products to be delivered to the appropriate PDS node. In cases where the reduced data products are very small, Instrument Teams may negotiate to have those sets included with the EDRs, if this can be done in a timely manner.

The Participating Scientists will generate reduced or derived data products. It is the responsibility of the Science Operations Groups to determine which, if any, of these products should be archived..

The Navigation and Ancillary Information Facility (NAIF) will generate the SPICE volume(s).

Generation of PDS catalog objects containing instrument and data set metadata for populating the PDS Catalog is the responsibility of individuals or teams producing the volumes, or as noted in Table 5. The MPF Project will provide the Mission and Instrument Host catalog objects.

3.2 Validation and Delivery

It is the responsibility of volume producers to validate their data products and volumes.

Archive volumes shall be validated for integrity of data content, file structures (e.g., conformance to Software Interface Specification documents), directory structures, compliance with PDS standards, and integrity of the physical media used to transfer the volume sets. This validation will be overseen by the Pathfinder Archives Working Group (PAWG) and specifically by the PDS Nodes eventually responsible for the archive of specific volumes.

The EDR volumes produced by MIPL, some with associated derived data products, will form the bulk of the MPF archives. Instrument

Teams (Principal Investigator or Team Leader) will have analyzed their data sets during mission operations, and will also review their data sets as part of validation of the archive CDs.

In cases where the Instrument Teams will be producing separate derived product volumes, they will determine when the volumes are ready for transfer to the PDS. Errors, if minor, may simply be documented. Large errors would require corrections and regeneration of the respective volumes. If given volumes pass validation, then the Principal Investigator or Team Leader would transfer the archives to the PDS, based on the release schedule delineated in Section 5 of this Plan

PDS representatives will review archive volumes as they are made available. The PDS Central Node and Imaging Node will coordinate with the MPF Science Office to assure that there is appropriate distribution of the review volumes. Problems due to obvious errors in science, missing files, and inadequate documentation will be referred back to the PI/TL, or other volume producer, for correction.

4.0 ROLES AND RESPONSIBILITIES

4.1 Overview

In this section the roles and responsibilities for personnel and organizations involved in MPF archive generation, validation, transfer, and distribution are summarized.

Table 5 lists the suppliers for each component of the archive volumes. The author of each archive volume or volume set is responsible for publishing a Software Interface Specification document that delineates the format and content of the respective volumes. An example outline is given in Appendix IV. That SIS, and SIS's for each included data product are to be included as part of the respective volume sets. Due to the abbreviated nature of the MPF mission, the Project will not be providing data product SISs except for the EDRs and in cases where SISs already exist for multi-mission products. Where SISs are not available, the volume producer will provide adequate documentation to understand the product.

4.2 Coordination

4.2.1 MPF Science Office

The Project Scientist and the Project Science Group (Project Scientist, Team Leaders, Principal Investigators, and selected Participating Scientists) provide an oversight function for implementation of the Archive Generation, Validation, and Transfer Plan.

4.2.2 Pathfinder Archives Working Group

The Pathfinder Archives Working Group (PAWG, a subgroup of MPF Project Science Group), will advise the Project with regard to archiving. The PAWG will consist of:

- an MPF Science Office representative
- the PDS Mission Interface Representative,
- PDS Node representatives
- the Multi-mission Image Processing Laboratory Team Member(s), and
- Instrument Team representatives

The PAWG will work in an advisory role with MPF and the PDS to help ensure that detailed plans are in place for generation of Planetary Data System-compatible products and associated documentation, and that archive volumes are generated, validated, and transferred to the Planetary Data System. The PAWG will coordinate the validation activity.

4.3 Archive Volume Production

4.3.1 MPF Project

The Project's Engineering Data Team will produce archive volumes containing Level 0 engineering data.

The MPF Project will provide funds for production (e.g., premastering of CD-ROM's) and distribution of archive volumes to the MPF community and to the PDS.

4.3.2 Multi-mission Image Processing Laboratory

The MIPL Team will compile archive volumes containing science packets for the Imager, APXS, Rover, and ASI/MET instruments. MIPL will produce archive volumes containing Experiment Data Records for each instrument. A subset of SPICE files will be included with these volumes. The MIPL team will also include derived products on some of the EDR volumes when it makes sense to do so due to the small nature of the instrument data sets.

4.3.3 Science Investigators

Principal Investigators, Team Leaders and Co-Investigators are responsible for generation and validation of reduced science data records, documentation, algorithms and software to generate the reduced data records, and archive volumes containing standard products and supporting information for their instrument.

Reduced data products produced by the Participating Scientists may be determined appropriate to include in the MPF archive. This plan will be updated to reflect any such determination.

4.3.4 NAIF

NAIF will produce the MPF SPICE volume(s), which includes the NAIF Toolkit.

4.5 Curation

4.5.1 Planetary Data System

The PDS is the primary organization within NASA responsible for the archive of planetary data. The PDS consists of a Central Node and several Discipline and Support Nodes. The responsibilities of the various Nodes of the Planetary Data System with regard to the archive of MPF data are summarized in Table 3. The Imaging Node is the lead PDS node with respect to archiving MPF products.

The PDS will work with the MPF project via the PAWG to ensure that the MPF archives are compatible with PDS standards. The PDS will maintain active archives of released MPF products for access by the science community.

The PDS Central Node maintains a database of catalog information on all PDS holdings which will be updated after MPF archival volumes have completed the validation process.

The PDS will distribute archive volumes to the NASA-supported science community, as funding permits. The PDS will also assure that archive volumes are provided to the National Space Science Data Center.

4.5.2 National Space Science Data Center

The National Space Science Data Center will maintain a "deep archive" of the data for long term preservation. The NSSDC will also be responsible for filling large delivery orders to the science community and making data available to foreign investigators, educators, and the general public.

5.0 Schedules for Release of Archive Volumes

Per the Pathfinder Data Release Policy, it is the responsibility of PI's and TL's to release archive volumes to the PDS by six months after receipt of data on the ground.

During the time between receipt of the data and delivery to the PDS, data products will be generated and validated, and archive volumes will be assembled and placed on either CD-WOs or CD-ROMs, and the volumes validated.

Science packets, SPICE files, and algorithms/software used in generating reduced data products should be delivered at the same time as reduced data records generated from the relevant science packet data.

The first delivery to PDS will be February, 1998, six months from the end of Prime Mission. This will be followed by a second delivery in six months, August, 1998, with the final delivery of all Mission products one month after end of Extended Mission, September, 1998.

Overview of MPF Archive Volume Generation, Validation and Transfer

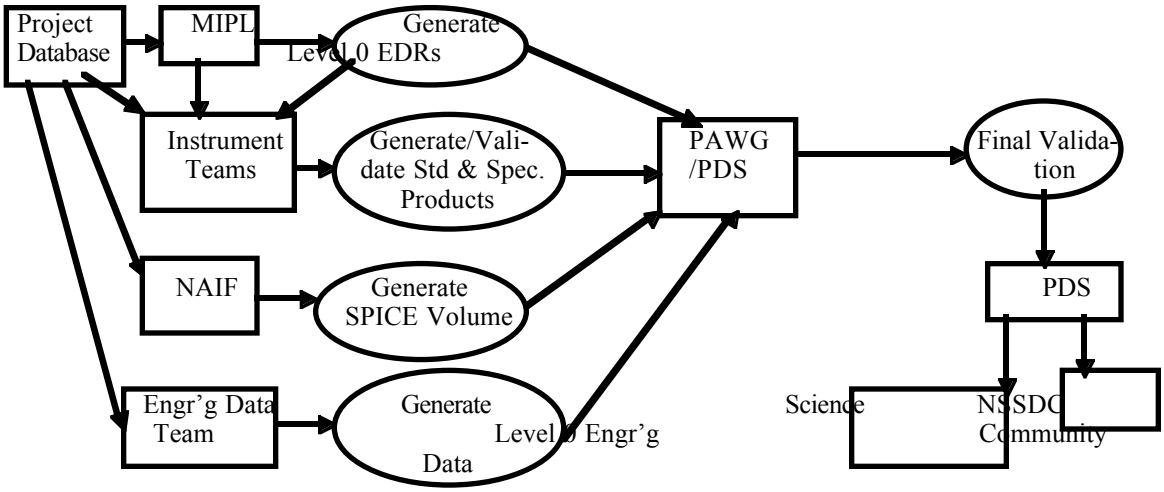


Figure 1 - Flow of data through MPF archive volume generation, validation, and transfer process.

Table 1 - Mars Pathfinder Instruments and Investigators.

Instrument	Description	Investigator	Role*
IMP (Imager for Mars Pathfinder)	A stereo imaging system with color capability provided by 24 selectable filters for the two camera channels. IMP also includes a magnetic properties investigation, the observation of wind direction and speed at three heights using small wind socks, and calibration, color and reference targets mounted to the lander	Peter Smith/ Univ. of Arizona Dan Britt/ Univ. of AZ (SOG Lead/Mineralogy&Geochemistry) Lyn Doose/ Univ. of Arizona Fritz Gleim/ U. of Braunschweig Ron Greeley/Arizona State H. Uwe Keller/ MPAe Jens Martin Knudsen/ Niels Bohr Inst Morton Bo Madsen/U. of Copenhagen Robert Singer/ U. of Arizona Larry Soderblom/ USGS Nicolas Thomas/MPAe/AIR SOG Lead Martin Tomasko/ U. of Arizona	PI/TL Co-I Co-I Co-I Co-I Co-I Co-I Co-I Co-I Co-I Co-I Co-I
APXS	Alpha particle sources and detectors for back-scattered alpha particles, protons and x-rays. The APX spectrometer will determine elemental chemistry of surface materials for all elements except hydrogen.	Rudi Rieder/Max Planck Institut fur Chemie Tom Economou/ U. of Chicago Heinrich Waenke/ Max Planck I.C	PI Co-I Co-I
Rover	NASA OSAT experimental semi-autonomous vehicle for navigation, soil properties, and other studies.	Jake Matijevic	TL
ASI/MET	A set of temperature & pressure sensors mounted on the lander. Provides profiles of atmospheric density, temperature & pressure.	John T. Schofield/JPL Jeffrey Barnes/Oregon State U A SOG Lead. David Crisp/JPL Julio Magalhaes/NASA ARC James. Murphy/NASA ARC Gregory Wilson/Arizona State U.	FIST Lead
Radio Science	Two-way radio system for precise measurement of lander position on rotating Mars. Allows estimation of rotation rate changes, planet moment of inertia, orbital variations and large asteroid masses.	William Folkner/JPL, ROD SOG Lead	PS

***PI-Principal Investigator,Co-I - Co-Investigator, PS-Participating Scientist, TL-Team Leader**

Table 2 - Participating Scientists

Name/ Location	Science Operations Group
Jim Bell/ Cornell	Mineralogy & Geochemistry
Bill Folkner/ JPL	Rotational and Orbital Dynamics, SOG Lead
Bob Haberle/ Ames	Atmospheric Sciences
Rob Hargraves/ Princeton	Magnetic Properties
Ralf Jaumann/ DLR	Geology/Geomorphology
Soren Larsen/ Riso Lab	Atmospheric Sciences
Hap McSween/ U. of Tennessee	Mineralogy & Geochemistry
Mike Malin/ MSSS	Geology/Geomorphology (SOG Lead: Tim Parker, JPL)
Henry Moore/ USGS	Surface Material Properties, SOG Lead
Scott Murchie/ JHUAPL	Mineralogy & Geochemistry
Al Seiff/ Ames	Atmospheric Sciences
Carol Stoker/ Ames	Geology/Geomorphology
Rob Sullivan/ Arizona State	Geology/Geomorphology

Table 3 - PDS Responsibilities for Archiving Mars Pathfinder Data

Planetary Data System Organization	Responsibility
Central Node/Mission Interface Team	Overall coordination with Mars Pathfinder Project, including joint planning efforts.
Geosciences Node	Archive APXS and Rover derived volumes.
Atmospheres Node	Archive ASI/MET volumes.
Imaging Node	Lead Interface for MPF Archiving, Archive Science EDRs, IMP & Rover derived volumes.
NAIF Node	Archive SPICE Volume and NAIF Tool kit, and Telemetry Packet Engineering Data Volumes.
Geosciences (Geophysics Subnode)	Archive Radio Science Volumes

Table 4 - Instrument Data Volume in Megabytes

Instrument	Data Product	Megabytes
IMP	Ground Calibration Data	4000
	Experiment Data Record	1000
	Derived products	12000
	TOTAL	17000
APXS	Fundamental Calibration Data	1
	Experiment Data Record	1
	Derived products	<1
	TOTAL	<3
MFEX (Rover)	Experiment Data Record (cameras)	50
	Technology Experiment Data	20
	TOTAL	70
ASI/MET	Experiment Data Record	47.8
	Calibrated Data	380
	Geophysical Parameters	190
	TOTAL	617.8
Radio Science	Orbit Data File (ODF)	4.4
	Archival Tracking Data File (ATDF)	1126.6
	Calibration Data	5.0
	TOTAL	1136.0

Table 5 - Mars Pathfinder Archive Volume Set Components and Suppliers

Volume Set	Volume ID	Contents	Data Supplier	Archive Medium	Volume Producer
APXS and Rover (MFEX) Experiment Data Record/Rover Engineering Data	MPRV_00XX	APXS EDR's Rover EDR's Rover Comprehensive Channelized Data Rover Technology Experiment Data Documentation Volume SIS EDR SISs: APXS, Rover Catalog Objects: Mission Instrument: APXS Instrument: Rover Cameras Instrument_Host: Rover Data_set: EDR	APXS Team Rover Team Rover Team - Allen Sirota Rover Team - Henry Stone MIPL - E. Duxbury MIPL - A.Runkle MIPL - E.Duxbury MIPL - E.Duxbury MIPL - E.Duxbury MIPL - E.Duxbury MIPL - E Duxbury	CD-ROM	MIPL - A.Runkle
APXS and Rover Derived	MPRV_10XX	Rover: Calibration Data & Camera Models Movies End-of Day Progress Over Time APXS: Oxide Abundances Elemental Abundances Calibration Raw Data (Earth laboratory) Calibration Oxide Abundances (Earth laboratory) Calibration Elemental Abundances (Earth laboratory) APXS Documentation: Calibration Comparison Results Inventory of APXS Files Location of APXS measurements Catalog Objects: Mission, Instrument, Instrument_Host Instrument: Rover Cameras	 Rover Team MIPL MIPL MIPL T.Economou/R.Rieder T.Economou/R.Rieder T.Economou/R.Rieder T.Economou/R.Rieder T.Economou/R.Rieder Project - J. Crisp MIPL - E. Duxbury MIPL - E.Duxbury	CD-ROM	MIPL - A.Runkle

		…Data_set: Elemental, Oxide Abundances Data_set: Rover Data	Project - J. Crisp MIPL - E.Duxbury		
ASI/MET (Contains all ASI/MET data)	MPAM_00XX	Raw ASI/MET EH&A Packets (EDRs) Raw ASI/MET EDL Packets (EDRs) Raw MET Surface Packets (EDRs) Raw Pressure, Temperature & Wind Velocity Measurements Calibrated Pressure, Temperature & Wind Velocity Measurements Temperature and Pressure Profiles Catalog Objects: Mission Instrument_Host: MPF Lander Instrument: ASI Instrument: MET Data_Set(s): Documentation Volume SIS EDR SIS	ASI/MET Team ASI/MET Team ASI/MET Team ASI/MET Team ASI/MET Team ASI/MET Team MIPL - E. Duxbury MIPL - E. Duxbury MIPL - E.Duxbury T.Schofield MIPL - E.Duxbury A.Runkle/T.Schofield	CD-ROM	MIPL - A.Runkle
Engineering Data Records	MPEN_00XX	Uplink Data: E-Kernels Downlink Data: Raw instrument packets Channelized engineering data Catalog Objects: Mission, Instrument_Host (Lander) Data_Set Documentation	K.Spellman M.Tankenson M.Tankenson MIPL - E. Duxbury M.Tankenson Spellman/Tankenson	CD-WO	Engr'g Data Team - K.Spellman
IMP Experiment Data Record	MPIM_00XX	IMP EDR's Documentation: Volume SIS EDR SISs IMP Calibration Report Catalog Objects: Mission, Instrument_Host (Lander) Instrument: IMP Data_Set: Ancillary Data: Index map/gazetteer	U of A - P. Smith MIPL - E. Duxbury MIPL - A.Runkle U. of A. - D. Crowe MIPL - E. Duxbury MIPL - E.Duxbury MIPL - E. Duxbury MIPL	CD-ROM	MIPL - A.Runkle

IMP Derived Products	MPIM_10XX	Mosaics/color images: Airbag Assessment, Mission Success, Seq 1, Pre-ramp Deploy, Monster, Gallery, Insurance, Super Pans, Sunrise/Sunset Super Resolution Images Winds Products Magnet Data Calibration files & software Ancillary Products: Calibration -Color target/report Catalog Objects: Mission, Instrument_Host (Lander, Instrument (IMP) Data_set: Documentation: IMP Calibration Report	MIPL “ “ “ “ “ Ames/MIPL - Tim Parker ASU - R. Sullivan Denmark U. of A. Peter Smith MIPL MIPL - E. Duxbury U. of A. - D. Crowe	CD-ROM	MIPL
IMP Derived Products - II	MPIM_20XX	Panoramic Maps Planimetric Maps Topographic Data: Panoramic Mosaics Digital Terrain Models Spectral cubes Catalog Objects: Mission, Instrument_Host (Lander), Instrument (IMP) Data_set	USGS USGS USGS USGS MIPL - E. Duxbury USGS	CD-ROM	USGS
IMP Ground Calibration Data	MPIC_00XX	Pre-flight calibration data IMP Calibration Report	U of A - D.Crowe	CD-WO	Bob Reid, U of A
Radio Science Data Records	MPRS_00XX	Packet Level Data (ODF’s and ATDF’s) Range and Doppler Measurements Viking Orbiter Range & Doppler Measurements Calibration Data Documentation Data Product SISs	W. Folkner W. Folkner W. Folkner W. Folkner W. Folkner	CD-WO	W.Folkner

		Catalog Objects: Mission, Instrument_Host (Lander) Instrument Data_Set, References	MIPL - E. Duxbury W. Folkner W. Folkner		
SPICE Data	MPSP_0001	SP & PC Kernels, and LSK Local level, Lander & Surface Fixed C Kernels EK Dictionary Files IMP & Project Experimenter's Notebooks SCLK File Updated EK (Lander_EK) IK - IMP and ASI-MET Rover EK (ROVER_EK) Rover SPK, CK NAIF Software Catalog Objects: Mission, Instrument_Host Data_Set: MPF SPICE Data Set	NAV Team " " NAIF-B.Semenov NAIF with inputs from Instrument Team members MGSO-D.Wagner NAIF - B.Semenov NAIF - B.Semenov Rover Team NAIF-B.Semenov NAIF-B.Semenov MIPL - E. Duxbury NAIF - B.Semenov	CD-WO	NAIF

APPENDIX I -- Glossary of Selected Terms

Calibration data - Calibration files used in the processing of the raw data or needed to use the data.

Catalog Information - High-level descriptive information about a data set (e.g. mission description, spacecraft description, instrument description), expressed in Object Description Language (ODL) which is suitable for loading into a catalog.

Catalog Object - A set of required keywords with values used to provide data for a data product or data set that is suitable for loading into a PDS catalog. A catalog object template that is filled in with values becomes a catalog object.

Data Product - A labeled grouping of data resulting from a scientific observation. A product label identifies, describes, and defines the structure of the data. Examples of data products are planetary images, spectrum tables, and time series tables.

Data Product Label - Required metadata for describing the contents and format of data products. PDS labels are written in Object Description Language (ODL).

Data Set -- An accumulation of data products, secondary data, software, and documentation, that completely document and support the use of those products. A data set may reside on one or more volumes; multiple data sets may also be stored on a single volume or multiple volumes.

Data Set Collection - A data set collection consists of data sets that are related by observation type, discipline, target, or time, and therefore are to be treated as a unit, to be archived and distributed together for a specific scientific objective and analysis.

High-level catalog - Database of high-level descriptive information about mission, spacecraft, instrument, data sets, and related items. Maintained by PDS Central Node. Catalog inputs derived from catalog objects expressed in Object Description Language (ODL) which are suitable for loading into a catalog.

Reduced data records - Raw science data that have been processed to some level and output as set of data products.

Science packets - Level 0 (raw) data for a given instrument in packetized form.

Standard data product - A data product generated in a predefined way using well-understood procedures. Processed in "pipeline" fashion.

Volume - A volume represents a single unit of physical media such as a CD-ROM, a CD-WO, or magnetic tape. Data sets may reside on one or more volumes and multiple data sets may also be stored on a single volume. Volumes are grouped into Volume Sets.

Volume Set -- One or more archive volumes which form a logical grouping. An example of a volume set would be the IMP Experiment Data Records.

APPENDIX II - Definition of Processing Levels for Science Data Sets

The following table describes the various levels of science data processing, and associates the NASA Level terminology with the CODMAC Level terminology where noted.

NASA	CODMAC	Description
N/A	Raw - Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level-0	Edited - Level 2	Instrument science packets (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.

NOTE: Following levels correspond to Reduced Data Records and may correspond to Standard or Special Data Products.

NASA	CODMAC	Description
Level 1-A	Calibrated - Level 3	Level 0 data which have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).
Level 1-B	Resampled -Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the instrument measurements (e.g., radiances, magnetic field strength).
Level 1C	Derived - Level 5	Level 1A or 1B data which have been resampled and mapped onto uniform space-time grids. The data are calibrated (i.e., radiometrically corrected) and may have additional corrections applied (e.g., terrain correction).
Level 2	Derived - Level 5	Geophysical parameters, generally derived from Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived - Level 5	Geophysical parameters mapped onto uniform space-time grids.

APPENDIX III - Descriptive Summary of Standard Data Products

Instru-ment	Product Name	Description
APXS	Experiment Data Record	Spectra of counts per channel for the alpha, proton, X-ray, and alpha-proton anticoincidence (background) detectors. Pristine data as received in the downlink telemetry; uncalibrated.
"	Elemental Abundances	Table listing the abundances of the major and minor elements in rocks and soils on Mars, based on X-ray data from the Alpha Proton X-ray Spectrometer.
"	Oxide Abundances	Table listing the abundances of the major and minor elements in rocks and soils on Mars, expressed as oxides, based on X-ray data from the Alpha Proton X-ray Spectrometer.
ASI/MET	Experiment Data Records	Time-ordered, raw ASI/MET EH&A, ASI/MET EDL, and MET Surface packets.
"	Raw Pressure, Temperature and Wind Velocity Measurements	Packet data records, converted to real units.
"	Calibrated Pressure, Temperature and Wind Velocity Measurements	Calibrated packet data records.
"	Temperature and Pressure Profiles	ASCII tables of temperatures versus pressure and altitude.
IMP	Experiment Data Records	Decoded, decompressed image data in single frame form. Pristine data as acquired by the spacecraft; contains the radiometric and geometric characteristics of unprocessed and uncorrected data
"	Mosaics	Imager mosaics of controlled digital images that have undergone radiometric, geometric, and photometric rectification
"	Super Resolution Images	Composite color frames made by combining 7 frames from the IMP camera right eye. The frames are taken with different color filters, enlarged by 500% and co-added. The result is then colorized with red, green and blue filtered images from the same sequence and the color balance adjusted to approximate the true color of Mars.
"	Panoramic Maps	Imager mosaics with panoramic coverage. The maximum size of an IMP panorama, for full azimuth and elevation coverage, is approximately 6000 samples by 2000 lines with the possibility of one or more bands. A set of eleven panoramic maps is planned.
	Planimetric Maps	High resolution maps of the Insurance and Gallery sequences. A set of 3 maps is planned.
"	Spectral cubes	Three cube products for each of 119 positions in the Super Pan sequence which had data for all fifteen filters. For each position the following will be generated: (1) eight-band registered right-eye, (2) seven-band registered left-eye, and (3) fifteen-band right-eye-rectified registered to left eye. Each cube will have four backplanes containing global x, y, z, and local range from camera
"	Topographic panoramic mosaics	Panoramic mosaics with three 32-bit floating point bands. The three bands represent x, y, z positions at each pixel. These mosaics will be generated for Pre-deploy and Post-deploy right and left eye geometry and will be half the resolution of the standard products in the panoramic archive. A set of 4 mosaics is planned.
"	Digital Terrain Models	Planimetric digital terrain models (DTMs). The DTMs will be 5000 samples by 5000 lines with 32-bit floating-point Z-value (elevation) pixel representations. A set of two DTMs is planned.

"	Wind Products	ASCII table of deflections and azimuths of windsocks for each windsock image
"	Magnet Data	Magnet Image Spectral Data and Calibration Paper
MFEX Rover	Experiment Data Records	Decoded, decompressed Rover image data in single frame and band-sequential color form.
"	Technology Experiment Data	Channelized data for the following experiments: Soil Mechanics, Wheel Abrasion Experiment, Material Adherence, Experiment, Telecommunications Link Effectiveness , Navigation, Thermal, Power
"	Movies	Movie sequence images of Rover activities (Imager provided)
"	Rover End-of-Day	Sequences of images showing Rover location at end of each martian day (Imager provided).
Radio Science	Archival Tracking Data File	Raw closed loop data records.
"	Orbit Data File	An edited subset of data from ATDF records.
	Range Measurements	ASCII tables of range measurements including DSN transmitting and receiving stations, time of receipt of signal, round trip light time and estimated measurement error in microseconds.
"	Doppler Measurements	ASCII tables of Doppler measurements including DSN transmitting and receiving stations, time of receipt of signal, round trip light time and estimated measurement error in microseconds.
Space-craft	Archival Engineering Data Record	Raw Engineering and Instrument Packets and tables of channelized data.

APPENDIX IV - Archive Volume Set Software Interface Specification Outline for Instrument-Related Data

Note: The purpose of producing an Archive Volume SIS is to provide a structure for organizing a volume collection. By completing the SIS the producer will effectively have designed the individual volumes and collection..

1. Introduction
   - 1.1. Overview
   - 1.2 Scope
   - 1.3 Contents
   - 1.4 Applicable Documents and Constraints

2. Interface Characteristics

   - 2.1 Hardware characteristics and Limitations
   - 2.2 Volume and size
   - 2.3 Interface medium Characteristics
   - 2.4 Backup and duplicates

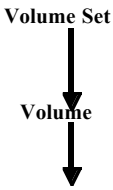
3. Media Content and Format
   - 3.1 File Formats - *Details of distinct file formats found in the volume set.*
     - 3.1.1 Document Files
     - 3.1.2 Tabular Files
     - 3.1.3 PDS Label Files
     - 3.1.4 Catalog Files
     - 3.1.5 Software Files
     - 3.1.6 Science Data Files

   - 3.2 Structure and Organization. *Provides details as to how components are grouped into physical volumes*
     - 3.2.1 Disc Organization (Directory Contents) for Volume Set 1
       - 3.2.1.1 Root Directory
       - 3.2.1.2 Calibration Directory
       - 3.2.1.3 Documentation Directory
       - 3.2.1.4 Catalog Directory
       - 3.2.1.5 Geometry Directory
       - 3.2.1.6 Software Directory -
       - 3.2.1.7 Index Directory
       - 3.2.1.8 Data Directory(ies)
     - 3.2.2 Disc Organization for Volume Set 2...
     - …
     - 3.2.n Disc Organization for Volume Set N...

4. Detailed Interface Specifications. *Descriptions of each file in the Volume Set.*

5. Support Staff and Cognizant Persons

Appendix V - Directory Structure & Contents of a Typical PDS Volume for an Instrument



AAREADME.TXT (User Information)*
VOLDESC.CAT (Volume Object)*
ERRATA.TXT (Anomaly Information)

SUBDIRECTORIES:

DOCUMENTa-tion	**CATALOG**	**LABEL**	**SOFTWARE**	**CALIBration**	**GEOMETRY**	**INDEX***	**DATA***
Document #1: Information	Catalog Inform.	Detailed Data	Source Code	Calibration Tables	SPK File	Index Table	Data Product Label
Volume Organiza-tion Object#1			Build Instruc-tions	Calibration Images	CK File EK File		Primary Data Object#1 Supplemental Data
Science #2 Papers			Platform Support		Et.al. "SPICE" files		Data Product Label Primary
Data Volume SIS							Object #2 Supplemental Data
Data Product Object#2 SISs							
Et.al.							

Directory Contents:

ROOT Directory: Top level directory of a physical or logical volume.

DOCUMENT Subdirectory. Contains all the textural material athat describes the mission, s/c, instruments(s), and data set(s). This can include references to science papers, or the actual papers. The Volume SIS and any data product SIS's belong in this directory.

CATALOG Subdirectory. Contains all the completed catalog objects for the mission, s/c, instrument(s), and data set(s).

LABEL Subdirectory. Contains additional PDS labels and/or include files (meta data or descriptive information) which were not packaged with the data products or in the data subdirectories.

SOFTWARE Subdirectory. Contains the software libraries, utilities, or application programs to access/process the data objects. It may also include algorithms.

CALIBration Subdirectory. Contains the calibration files used in the processing of the raw data or needed to use the data products on the volume. CALIB is only a recommended directory name.

GEOMETRY Subdirectory. Contains files needed to describe the observation geometry. Optionally may contain some/all relevant SPICE files that are also available in the project's SPICE archive volume set.

INDEX Subdirectory. Contains the indices for the data products in the data set(s) on the volume.

DATA Subdirectories. Contain the data product files. Data products may be packaged with their PDS labels attached, where the label and the data objects(s) are contained in a Labeled Data File, or with PDS labels detached, where the PDS label is contained in a Label File and the data object(s) in a Data File.

* An asterisk indicates the particular file or directory is required.